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The Scout's Book of Observation

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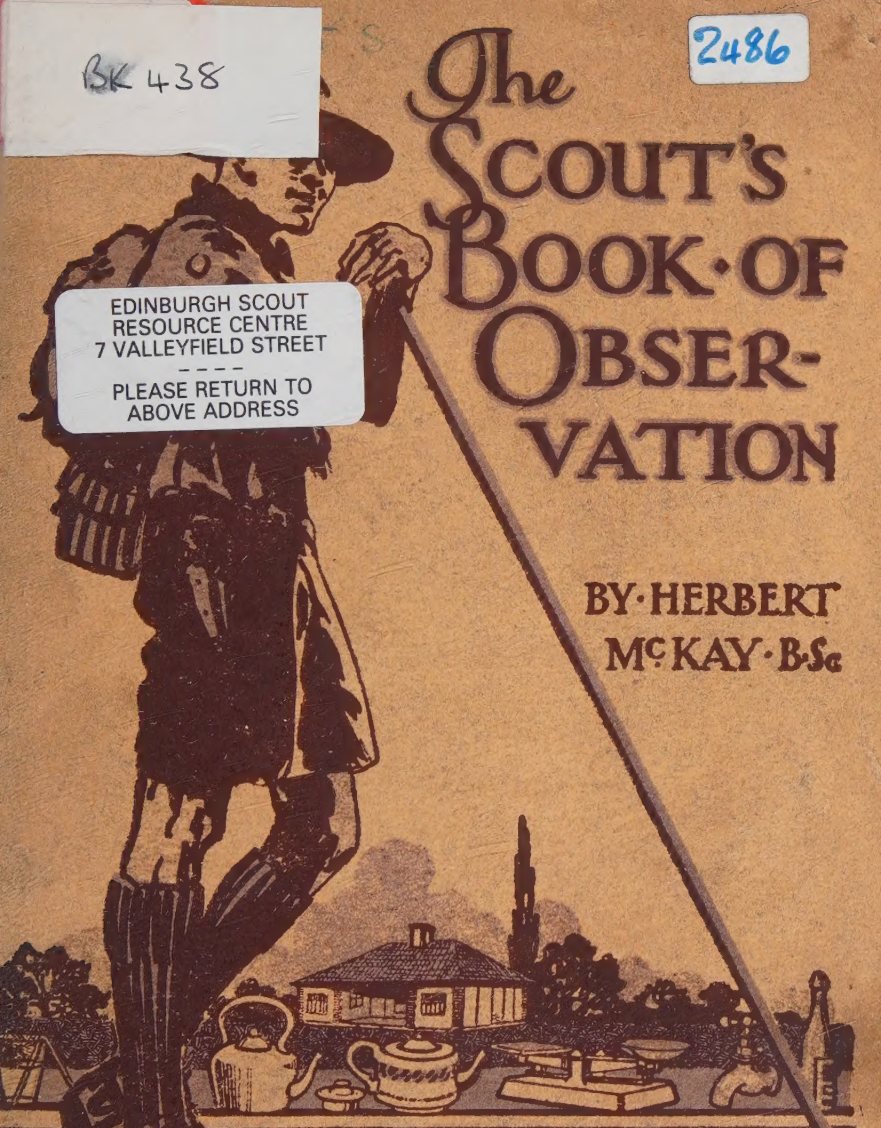
BY HERBERT
McKAY B.Sc



HANDICRAFT
BOOKS FOR SCOUTS

Nº 42

THE SCOUT'S BOOK OF OBSERVATION

(IN THE HOME)

THE HANDICRAFT BOOKS FOR SCOUTS

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HUMPHREY MILFORD
OXFORD UNIVERSITY PRESS

THE SCOUT'S BOOK OF OBSERVATION
(IN THE HOME)

BY

HERBERT McKAY, B.Sc.

AUTHOR OF
"THE SCOUT'S DESERT ISLAND BOOK"

WITH NUMEROUS DIAGRAMS

HUMPHREY MILFORD
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DO YOU KNOW——

Why kettles for gas-rings are made flat?
How to put right an electric bell?
Why there is a little air at the top of a bottle?
How to fix up or strengthen a shelf?
How to clean a lock?
Why carved table legs are undesirable?
How an electric switch works?
How to read a gas meter?

The Scout's Book of Observation not only answers these questions — and hundreds of other questions about the home—but shows you *how you can find out for yourself.*

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43rd Troop
No. 42

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I.—HOW TO OBSERVE

THERE are several ways of observing. One method is to note facts and to remember them. We are, however, surrounded by so many details that this method is rather hopeless. It has the additional disadvantage that it depends entirely on memory. If memory fails there is no means of restoring the observation.

Another method is to select the things we mean to observe, and to look for reasons why a thing should be formed in one way and not in another. This is evidently a much higher form of observation. If we forget, we can reason the matter out again.

In this book suggestions are made for beginning systematic observation of the things about us. The book deals entirely with the home, but this is only a start in learning to observe. Each of the suggestions made may be carried a little farther.

Throughout the book are explanations of the purpose of things. Some of these may seem very obvious. They are so obvious that we sometimes forget all about them! A window is intended to let in light and air; but if we keep the window closed, and half cover it with curtains, and leave eight or ten inches of opaque blind over the lightest part of it—it is just as well that we should remind ourselves of the purpose of windows, isn't it?

II.—DRAWING AND OBSERVATION

DRAWING may be very useful as a help to observation. If you are examining an object, begin by

making a drawing of it from memory. You will find yourself asking questions. These are the questions which you should try to answer by observation and reasoning.

The kind of drawings which are useful as a help to observation are such as are contained in this book, which are intended to show details accurately. Drawings showing the general shapes of objects are of little use for this purpose, though it is best to begin with such drawings and to add the details afterwards.

When you have finished your examination of any object, make a second memory-drawing. This will show whether you have observed correctly, and especially whether you have found the reason for each detail in the thing you have been studying.

III.—A TEAPOT

A TEAPOT is made to hold hot tea and to keep it hot.

The spout.—The spout of a teapot rises to the level of the top of the pot. Otherwise tea would pour out if the pot were filled. It is not made any higher because additional height would make it more liable to be broken, without giving any compensating advantage.

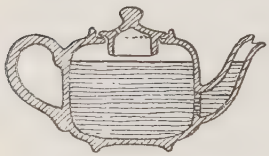

Fig. 1.

The bottom of the spout is made wide so as to allow ample room for attaching it to the pot. The top is narrower to allow an even flow. The end is turned down to direct the stream of tea downward, and a notch is cut in it to even the air pressure and allow the tea to pour out smoothly.

The lid.—Two points to note about the lid are the depth, which prevents it falling off when the teapot is tilted, and the hole in it, which allows steam to escape. If steam formed under the lid it would press down on the tea and force it out of the spout.

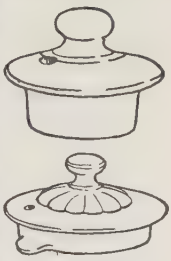

Fig. 2.

The handle.—In a silver teapot the handle is usually made of ebonite. You will see the reason if you touch a silver teapot containing hot tea. Heat passes readily through silver, and the outside is very hot. Heat does not pass easily through ebonite, so that an ebonite handle does not become hot.

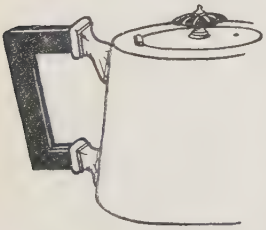

Fig. 3.

In an earthenware teapot the handle is cool enough to hold because heat does not pass readily through earthenware.

Keeping tea hot.—Hot tea soon becomes cold even in an earthenware pot. It is necessary, therefore, to cover the teapot with a cosy. The cosy contains some fluffy material which does not let heat pass through it easily.

IV.—A KETTLE

A KETTLE is a vessel to hold water so that it may be readily heated.

Shape of a kettle.—Like the teapot, a kettle must have a spout coming up to the level of the top. It is more necessary than in a teapot to have a hole in the lid.

The handle is above so that it is out of the way of the flames. There is usually some method of checking the flow of heat to the handle. If there is not, it is necessary

to use a holder (cloth material or paper) to prevent the hand being scorched.

The bottom of the kettle should be flat to allow a large heating surface. Kettles to be heated over gas

Fig. 4.

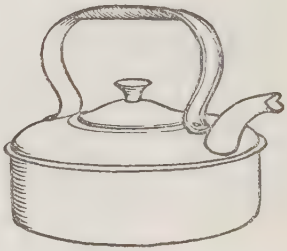

Fig. 5.

often have upright sides, and are rather shallow. You may find other methods of increasing the heating surface.

Soot.—The effect of soot may be found by experiment. Fill a tin lid with soot, put it over a gas ring, and place on it a small tin of water. Note how long the water takes to boil. Now repeat the experiment with everything the same (height of gas flame, quantity of water, same tin and lid) except that there is no soot.

This experiment should show the advantage of keeping kettles free from soot.

The inside of a kettle.—Examine the inside of a kettle that has been in use for some time. You may find the sides lined with "fur." Mineral matter which was dissolved in the water has become deposited on the sides. This checks heat coming through from the flame, and it should be removed from time to time. Little balls of wire gauze are sold to be put in kettles to collect "fur" and break it up.

Heating vessels.—Teapots and coffee-pots are often heated by pouring boiling water into them. Pour

boiling water into an earthenware teapot and put your hands on the outside. You will find that it takes a little time for the heat to come through. When heating any vessel with boiling water the water should be left for a short time to heat the vessel thoroughly.

A hint on making tea and coffee : See that the water is boiling hard, and keep the kettle over the flame whilst the water is being poured out.

V.—CUPS AND SAUCERS

A CUP is intended to hold hot tea. A saucer is a protection between the cup and the table.

The shape of a cup.—Cups, as well as other things made of china, are round. This is the easiest shape to make on the spinning potter's wheel, though it would be difficult to model a good round cup without the wheel.

The handle is just wide enough conveniently to hold the finger. Notice how the clay has been pressed down where the handle is joined to the cup so as to give a better hold.

It may be noted that some cups are high and others are wide. Test two cups by filling each with hot tea and tasting the tea after a few minutes. It will be found that the high cup keeps the heat longer. More heat is radiated from the wider surface. The narrower and taller shape is therefore to be preferred because it serves its purpose better.

Fig. 6.

The ring at the bottom of the cup may be noted. This enables the cup to sit flat. It is a very common device, and may be noted in saucers and basins.

The glaze.—Things made of china are usually glazed. After the clay cup has been baked it is dipped in milk

of felspar (one of the components of granite, crushed, and mixed with water). The cup is then baked again, and the felspar forms the glaze.

Before clay vessels are glazed they are porous and liquids ooze through them. The glaze makes them impervious to liquids.

(In India unglazed vessels are used for holding drinking water. These are hung up in a draughty place. A little water oozes through, evaporates, and so cools the water in the jar.)

Saucers.—A saucer keeps any chance drops of tea from reaching the table. It also keeps the hot cup from the table. The air space between cup and saucer helps greatly in keeping heat from the table.

A saucer is a flat surface turned up at the rim so that it is easy to pick up.

Sugar in tea.—Here is an interesting little experiment in dissolving sugar in tea (though you can see the sugar better in hot water). Put a lump of sugar in a cup of hot water and leave it. It will remain for some time undissolved. Held in a spoon near the surface of the tea, the sugar breaks up and dissolves much more quickly.

The reason for the difference is that, when the sugar is at the bottom of the cup, air round the particles of sugar is held there by the pressure of the tea above, and so protects the sugar. Look for escaping bubbles of air when the sugar does dissolve.

VI.—A TABLECLOTH

The material.—Examine a tablecloth with a magnifying glass. Two sets of fibres will be seen crossing each other at right angles. One set is thick and strong—the warp. The other is thinner and fleecy—the weft. The warp gives strength to the material, the weft gives smoothness.

It may be seen that the weft is alternately above and below the warp. Patterns are made by passing the

weft over three strands of the warp, under two strands, over four, and so on. Variations of this kind may easily be detected with the magnifying glass.

When linen is being woven, the threads of the warp are first strung across the frame. Alternate threads (or other sets) may be brought forward. The shuttle, carrying the weft, then passes between the two parts of the warp. The two sets of threads are then interchanged, the shuttle flies back, and so on.

Examine various materials with the glass. In each case you should be able to detect the difference between the strong threads of the warp and the fleecy threads of the weft.

Colour.—Tablecloths should be very white. After the material is woven it is soaked in bleaching powder and water, and laid out in the sun to bleach. The appearance of tablecloths may be improved by leaving them to dry in bright sunlight after they have been washed. This still further bleaches them.

VII.—BOTTLES, JARS, TINS

Bottles and jars are intended to keep liquids and semi-liquids safe from contamination. Tins are used to hold solids as well as liquids.

Fig. 7.

Bottles.—An interesting point about a bottle is the cork. You can show, by rolling a cork or by squeezing it, that it is elastic.

Examine a corked bottle. You may find it nearly full of liquid, but near the top there is a small amount of air. Without this air corking would be impossible. Fill a bottle quite full of water and try to cork it. You will find that the cork cannot be forced in because the water is hardly compressible. Now pour out a little of the water, and the cork can be pressed in at once. (The air is readily compressed.)

You may also notice that a cork is compressed when it is forced into the neck of a bottle, so that it fits tightly. If there is any difficulty in forcing a cork into a bottle, the cork may be compressed by rolling it under the foot.

Jars.—Jam jars are usually covered with damped paper. The damp paper is tied tightly on the jar. When it dries it contracts and forms a tight covering.

Preserved fruit is sometimes kept in jars or bottles with covers held down by air-pressure. The cover is put on when the jar is hot and the upper part full of steam. To open these jars it is necessary to pierce the top. Air rushes in and equalises the pressures above and below. The top may then be lifted off.

Tins.—Cocoa and mustard tins are merely strong boxes for packing these things. The sealing of tins containing dry stuff need not be perfect.

Tins containing preserved fruit and other foods are very carefully sealed. On the tops of such tins you will find a little solder. After the tin is filled and the lid put on a small hole is left. The tins are then heated for some time to destroy germs. Finally the small hole is closed with solder. The food in the tin is thus freed from germs and kept from contamination.

You may notice that the tops of these tins are pressed in. This is the effect of outside air pressure when the steam in the tin condenses. Sometimes the food is contaminated, and gases form in the tin. The sides of the tin are then bulged out. It is dangerous to eat food from these tins.

In any case, food should be removed from tins as soon as they are opened. With these simple precautions, tinned food is wholesome enough, but fresh food is very much better, especially for young people.

VIII.—TABLES AND CHAIRS

Examine a well-made table. It is firmly made, and it stands evenly on the floor. A badly made table is rickety and it wobbles on its legs.

The frame.—The strength of a table is in the frame. Examine the frame by looking below the table. It will be found that it consists of an oblong of wood, each of the sides being strongly jointed to the legs. The frame and legs should be able to stand firm without the top.

The sides of the frame are made as wide as possible to add extra strength to the frame. Sit at the table and you will see why the frame is not made wider: there would not be room for your legs to go beneath.

The legs.—Examine the legs of the table. It will be seen that they are thick at the top so as to allow strong attachment. Lower down they taper elegantly. Sometimes table legs are highly carved, but such legs are merely dust traps.

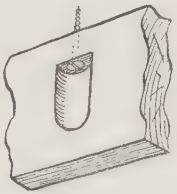

Fig. 8.

The top.—The interesting thing about a table top is that it contains neither screws nor nails. The top is fastened on from beneath. If you examine a table from below you will find that spaces have been gouged out in the frame. A sufficient width is left on the upper edge of the frame to hold the screw. The screws are of sufficient length to pass through the frame and half way through the top.

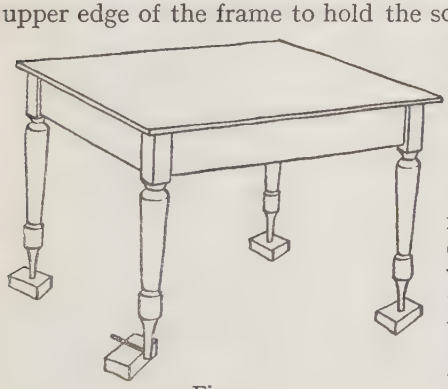

Fig. 9.

It may be noted that the table is further strengthened by square wedges glued to the frame and the top.

The top of a table is usually polished.

Levelling a table.—Examination will show that a

three-legged table or chair sits evenly on its three legs. A four-legged table or chair may wobble, because the legs " go in twos."

A wobbling table may be remedied by turning it into a three-legged table. Two of the legs are seen to be longer than the other two. Make up your mind which is the longer of these two. Cut off four short lengths from a piece of wood. Put three of these under the three shorter legs. The table will sit firmly on these three. Use the fourth piece of wood as a gauge to mark the fourth leg. Put it close to the leg and mark the height with a pencil round the leg.

Now cut carefully through the leg with a saw at the marked height. It will be found that the table then sits firmly on the four legs.

Chairs.—A chair is made (or should be made) to stand a heavy pressure in two directions. There is the downward pressure on the legs, and also the pressure on the back. Very often the uprights of the back are made in

Fig. 10.

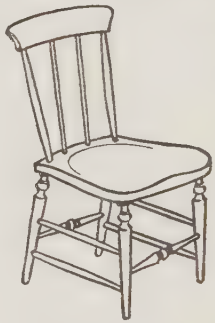

Fig. 11.

one piece with the back legs. The seat is supported at the back by being let into the legs. The weak point of a chair of this kind is where the uprights at the back are cut into. This is overcome by using thick pieces of strong wood.

In another kind of chair a number of uprights are let

into the seat. The only support in this case is the small hold of the seat on the uprights.

When you examine chairs, always look to see how the difficulty of the weak point has been overcome.

The legs of chairs are sometimes kept from moving sideways by putting struts between them. A better method is a large strong joint between the leg and the chair. Below the joint the leg may taper, very much as in the case of tables.

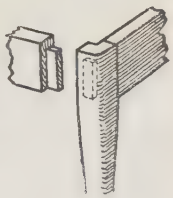

Fig. 12.

Wobbling chairs may be cured in the way suggested for tables.

IX.—A MIRROR

A SWINGING mirror is intended to give a reflection when placed at any convenient angle.

How a mirror is swung.—Experiment with a swinging mirror, and note that it will remain still at whatever angle it is placed. It is carefully suspended so that the

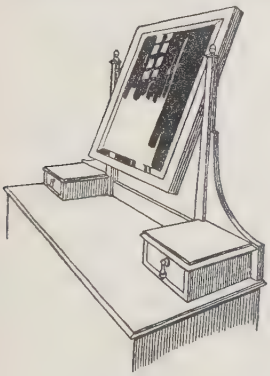

Fig. 13.

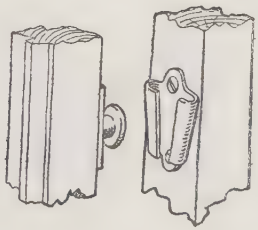

Fig. 14.

line on which it is swung is just on a level with the centre of gravity of the mirror. The slight friction

at the turning points is then sufficient to keep the mirror from moving.

How a mirror reflects.—Examine a small piece of looking-glass. It is ordinary glass with a coating of mercury, and behind this a coating of paint to protect it. You will see that the reflection comes from the bright surface of the mercury.

Hold a lighted candle an inch or two from a mirror and look at the reflection from the side. You will be able to see a faint reflection from the upper surface of the glass, and a bright reflection from the surface of the mercury. By putting the eye close to the glass you will be able to see several reflections. Light is reflected backward and forward between the outer surface of the glass and the surface of the mercury. You will see that the reflections become fainter and fainter.

Stand in front of a mirror and note the position of the image. It is as far behind the mirror as the object is in front. The line joining image and object crosses the mirror at right angles.

Experiment with a hand mirror and see how you must hold it to get an image of the back of your head. Hold a candle between two mirrors and note the long rows of images becoming fainter and fainter. The light is thrown to and fro between the mirrors, giving a new reflection each time.

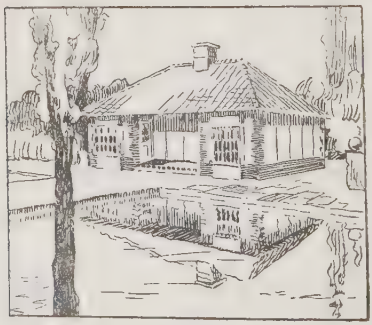

Fig. 15.

Other reflectors.—Look out for other reflectors. Here are some that you may easily find. A polished teapot or door knob gives a distorted image because it is not flat. Picture glass reflects light. (Look at a picture from the side away from the light.) Reflections come from

windows—a blaze of sunlight on windows is often seen, and reflections may be noted when windows are looked at from the light side. Sheets of water give very good reflections, especially when the water is contained in something dark, so that there is not much light coming through from below.

X.—DUST

The purpose of dust is—to be removed.

Where dust collects.—Put your finger, gingerly, on the upper surface of a picture rail or a wardrobe. You may find it free from dust or you may not.

Examine the furniture in a room before it has been dusted. You will find some dust on every upward surface. If there is any carved work you may be surprised at the number of surfaces which collect dust. A careful search of a room will show many places where dust collects (behind pictures, in curtains, and especially on upward surfaces near the ceiling and in corners). Carpets often contain much dust. A slight knock on most carpets will send dust flying out.

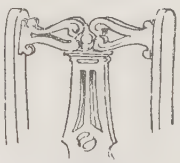

Fig. 16.

A good time to look for dust is when the sun is shining into the room. The amount of dust in the air, each particle lit up by the sunlight, is surprising.

Getting rid of dust.—The best way to deal with dust is to get rid of dust-traps. Arrange furniture so that there are no corners difficult to get at. Get rid of unnecessary ornaments, especially those with intricate surfaces. Simple, smooth surfaces are best in furniture and in ornaments.

The art of the duster is sometimes quite misunderstood. The purpose of a duster is to gather up dust and not to transfer it to the air to settle again. (Good dusters, like all good workmen, know the purpose of what they are doing.) If the windows are wide open while

dusting is going on, much dust will be carried out by the air.

XI.—PICTURE FRAMES

PICTURE frames are intended as a convenient means of hanging pictures on walls and preserving them from dust.

The frame.—Examine the corners of a frame. They are cut very carefully at angles of 45 degrees so that two sides fit together to form an exact right angle. Examine the sides and back to see how the corners are joined.

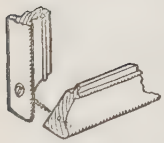

Fig. 17.

How dust is kept out.—The glass keeps out dust in front. You will see that it fits into a recess in the same way as a window pane.

If there is a picture frame open at the back, examine it before putting it right. You will find thin strips of wood pressed against the picture and held in place by small brads. The purpose of the wood is to keep the picture and glass pressed tightly to the frame so as to exclude dust.

Brown paper is stretched tightly over the back of the frame. The method of stretching may be shown by experiment. Cut a strip of brown paper about a foot long. Lay it out flat and mark the length exactly. Now soak the paper with water and lay it over the marks. You will find that it is longer when wet. Brown paper is wetted, and stuck to the frame with paste while still wet. When it dries it contracts and is tightly stretched.

Hanging pictures.—Pictures are usually slightly tilted so that they may be seen better. The tilt is obtained by putting rings in the frame above the middle. The

Fig. 18.

nearer they are to the middle the greater is the tilt.

One or two points may be noted about hanging pictures. Do not crowd them. The upper edges of the frames may be in line. The pictures themselves may form a design. The following sketch suggests

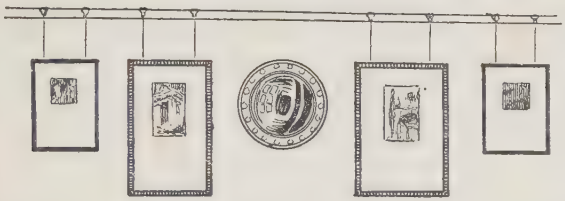

Fig. 19.

an arrangement. It may be noted that narrow black frames are used. These are neat, they do not "kill" the picture, and they do not harbour much dust.

XII.—SCALES

SCALES are intended to tell us the weight of things by balancing them against known weights—pounds and ounces.

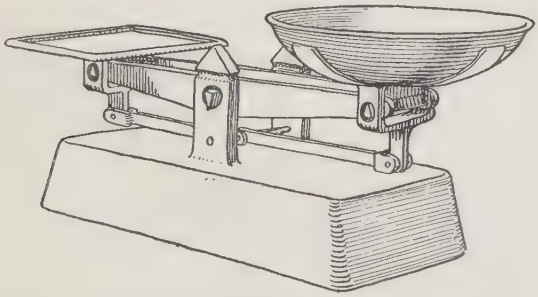

Fig. 20.

Parts of scales.—Examine a pair of scales. They vary very much, but the essential parts are the same.

There is a beam or crossbar balanced at its middle point on a knife edge. By itself the beam would balance. At each end is a scale pan. The two pans are of equal weight (though they may be different in form), and they are fixed at equal distances from the balancing point. Attached to the beam is a pointer. The swinging of the pointer indicates whether the scales balance exactly.

Testing scales.—Scales may be slightly inaccurate because the beam does not balance at exactly the middle point. The method of testing is easy. Weigh out a pound of some substance. Then interchange the pound weight and the weighed pound. If the balance is true the two weights will still balance.

Using scales. (1) To find the weight of a stone or other mass : Put the weights on the pan in turn, starting with the heaviest. If any weight is too heavy, remove it. If it is too light leave it, and add the next.

(2) To weigh out a pound of rice : Put a pound weight on one pan. Pour rice into the other until that side falls. Remove a little at a time till the balance is even.

(3) To weigh a pound of water : Begin by balancing a jar against weights of different kinds. Then add one pound weight. Pour in water until the balance is restored.

XIII.—HOUSES

A HOUSE is a place where human beings are to live. It would not be difficult to make a list of most of the things which a house should provide—warmth, light, fresh air, protection from the weather, places for cooking, eating, sleeping, storage. In addition you may put in the special requirements of civilised people.

Unfortunately it is easier to know what is wrong with houses than to put them right. Still, some good is done by knowing what is right and not being satisfied till you have got as near to it as possible.

Positions of rooms.—The positions of some rooms are very quickly settled. The larder should be at the coldest side of the house. Rooms where children sleep

and play should be light and sunny. It is always possible to rearrange rooms to make the best possible use of them—in spite of the builder.

Make a plan of your house. Measure the size of the rooms either by pacing or with a tape-measure. You can then roughly set out the rooms to scale. Make also a plan of the story above, and compare the two.

Note how the walls are carried up through the house. In most cases you will find that the inner walls (as well as the outer walls) are carried up from base to roof. In some cases, however, walls are added above. These are merely partitions; that is, they are made of laths covered with plaster. If you drive a nail into one of these partitions you will find that there is no hold for it.

It would be interesting to see how you can alter the plan of your house so as to make better use of the space.

Building a house.—When an architect is at work on a house he begins with the plan; that is, he lays out the available space to the best advantage.

The plan is set out full size on the ground—you may see this when a house is being built. Trenches are dug along the lines of the walls. The depth of the trenches depends on the size of the house to be built, and also on the kind of ground. In any case, the loose surface soil is cleared away, and the trench is filled with concrete (cement, sand, and pebbles or gravel). This is to form the foundations.

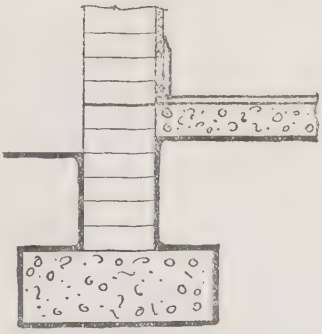

Fig. 21.

Sometimes the concrete is arranged in steps, and sometimes as shown in Fig. 21. A layer of concrete is carried across the whole site of the house. The foundations are made at least three times as wide as the walls they are to support.

The foundations are carefully levelled so that the walls may stand quite upright.

Foundations for heavy buildings.—If a church or other heavy building is being put up you may see much more elaborate foundations being laid. The best are made by digging down to the solid rock and building up from this. It is impossible for such foundations to give way.

On swampy land foundations are made by driving piles "to refusal"; that is, till they can be driven no deeper. The skyscrapers in New York are built on caissons. These are steel tubes going down to a depth of 200 or 250 feet and afterwards filled with concrete.

XIV.—WALLS

Walls are intended to stand upright. The chief difficulty in building is to make them exactly upright.

A plumbline.—Cut a small oblong of sheet lead, hammer it flat if necessary, make a nail hole near one edge, and fasten it to the end of a yard of thin string. For the upper end use a piece of thin wood (half the thickness of the lead). Tie the string to the wood so that it hangs touching one side. The sketch suggests a slight variation.

Fig. 22.

Use the plumbline to test the walls of your house. Hold the upper part flat against the wall with the string outside. The weight should just touch the wall. Test the wall in various places.

If you have a spirit level you may test whether the lines of bricks are level. Hold a thin board along the edge of a line of bricks and place the spirit level on it.

Arrangement of bricks.—Examine the arrangement of bricks in a wall. Fig. 23 shows a very common arrangement. The bricks are put on carefully so that the joints are never one over another, and there is always

the middle of a brick over each joint. The advantage of this arrangement is that any weight on the brick marked A is evenly divided between the bricks B. These spread it over the bricks C, and so on down to the foundations. The result is that pressures (of the walls, floors, roof, people, furniture, etc.) are spread evenly over the foundations. The weight of a piano, for example, is not borne by the small part of the foundation just under it, but is spread by the bricks over a great area.

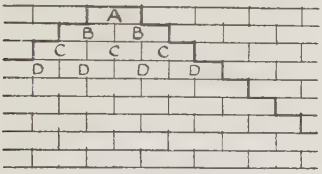

Fig. 23.

You may find other arrangements of bricks in a wall. Sometimes, instead of the sides showing as above (" stretchers "), the ends show, as in Fig. 24 (" enders "). It may be noted that enders only spread a weight over half the distance that stretchers spread it.

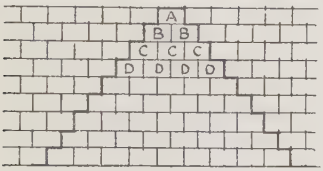

Fig. 24.

Another arrangement, enders and stretchers alternately, is shown in Fig. 25.

Thickness of walls.—The size of a brick is about 9 inches long, $4\frac{1}{2}$ inches wide, and nearly 3 inches deep. The thickness of a wall may therefore be 9 inches, 14 inches, 18 inches, etc. (*i. e.* one brick, one and a half bricks, two bricks, etc.).

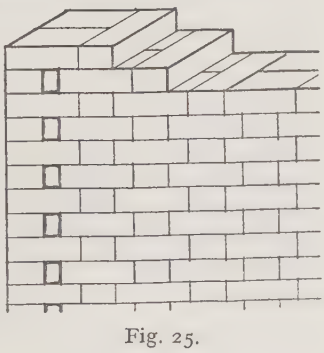
Fig. 25.

Fig. 26 shows a modern way of building walls. It may be seen that the wall is really two walls

with a space between. Notice the clamp which binds the two together. These clamps are fixed at intervals. Walls built in this way keep out damp very efficiently.

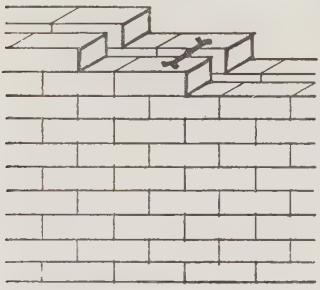

Fig. 26.

When building is going on you may see how the different courses are laid and how walls of various thicknesses are tied.

Mortar.—The spaces between bricks are (or should be) filled with mortar. The bricklayer spreads mortar over the last course laid, puts a damp brick in place, knocks it with his trowel, trims off the mortar, and runs the point of the trowel along the line of mortar between the courses. Every part of the process is important. If the brick were dry it would suck up water from the mortar near it and the brick and mortar would not be joined. (Mortar sinks into the pores of the wet brick and so makes the joint firm.) The brick is knocked down to drive the mortar into the pores and into all spaces between the bricks.

In Fig. 27, at A the mortar has been scraped away. At B it has been left bulging out. Bulging mortar, like that at B, collects any moisture that runs down the wall and begins to rot. It is also more exposed to frost, which crumbles it.

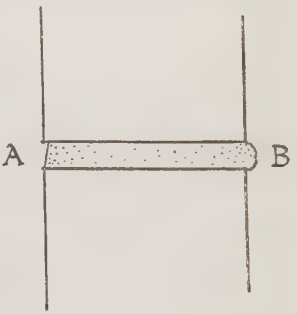

Fig. 27.

XV.—ROOFS

THE purpose of a roof is to prevent rain, snow, and wind entering a house.

Slope and covering.—Look at the shape of a roof. It usually slopes at an angle of about 45° (half a right angle). This causes rain to run off quickly, and also prevents great accumulations of snow. In a climate without snow a much shallower angle would do.

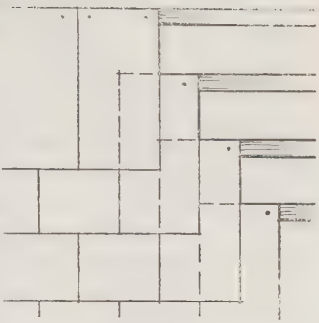

Fig. 28.

Roofs are usually covered with slates or tiles. The arrangement may be studied on low outhouses. In any row of slates each one overlaps the next so that there are no gaps. In the same way, each row of slates overlaps the row below it. There is thus no interval between the slates for rain to run through.

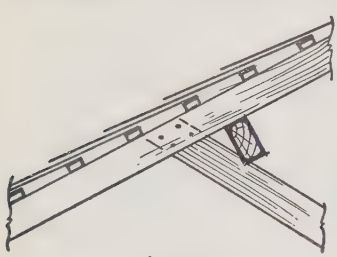

Fig. 29.

In putting on the slates the lowest row is put on first, then the row above, and so on. Each slate has small holes to allow it to be nailed to the rafters. The row of tiles at the top overlaps the slates on both sides.

How a roof is tied.—A roof is very heavy. It rests on the tops of the walls, and the great pressure would drive the walls outward if nothing were done to prevent it. The slanting beams are tied by a cross beam at the base. This beam fixes the shape by making it triangular.

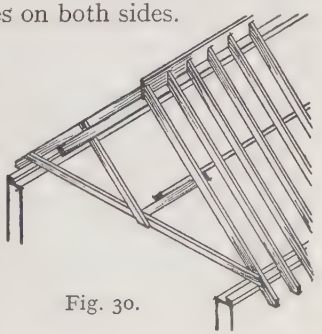

Fig. 30.

There is no possibility of the shape changing, and no outward pressure on the walls.

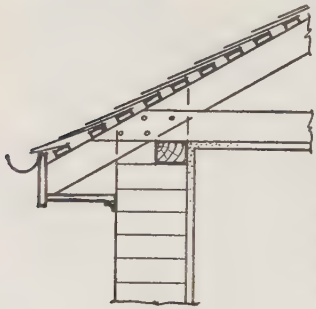

Fig. 31.

Drainage.—Rain falling on a roof runs down over the slates. It is prevented from running between the slates by the overlap. Along the edge of the roof is a cast-iron gutter, the upper edge of which runs under the lowest slate. Water from the roof runs straight into the gutter and so down the rain pipe.

XVI.—FLOORS AND CEILINGS

FLOORS should be firm and level, and they should not be too cold to the feet. Ceilings should be—white.

How a floor is laid.—If you examine a floor you will usually find floor boards fitting tightly together. The fit is made almost airtight by using boards that are tongued and grooved, the tongue of one board fitting into the groove of the next.

On an upper floor you may find a board cut so that workmen can get at the gas pipes leading to the room below. Electric wires may also pass through the ceiling in the same way. By removing the cut board you may see the joists that support the floor. Thin laths are nailed on below to form the ceiling of the room beneath. The joists are laid right across the room, and rest on the walls at either side. You may see them being put in when a house is being built. The ends rest on a beam built into the wall and running the whole length of it. This prevents the crumbling of a single brick from causing a joist to collapse (Fig. 32).

Fireplaces raise a difficulty because the joists cannot

be carried back to the wall at one side. This difficulty is got over by using crosspieces, which are held by the joists and support the ends of the short joists (Fig. 33).

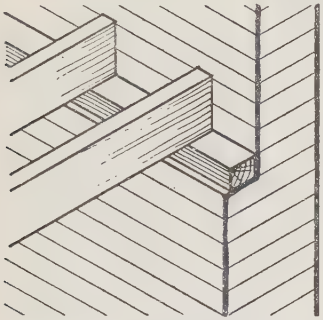

Fig. 32.

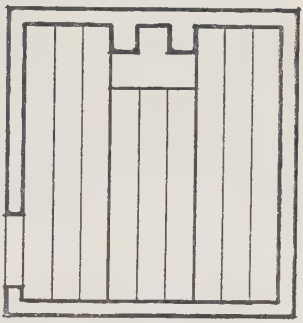

Fig. 33.

Ceilings.—Below the floor-joists of an upper room thin laths are nailed to form the ceiling of the room below. The laths are covered with plaster underneath. This is smoothed and whitewashed.

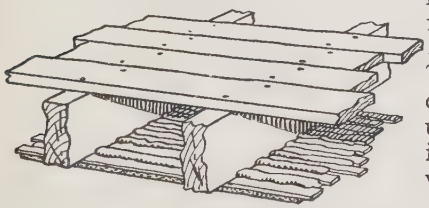

Fig. 34.

Ceilings provide broad white surfaces which help greatly to lighten rooms. It is necessary, however, to whitewash them frequently. A well whitewashed ceiling makes a great difference to the lighting of a room.

Fig. 35.

Floor coverings.—Stone floors are very cold and therefore bad for the health. Wood floors are better, but these are usually covered with some material which does not allow heat to pass through readily. Thick carpets are most effective for this purpose.

XVII.—A STAIRCASE

A STAIRCASE is one of those things in a house that we often take for granted, but it is really the most difficult part of a house to make well.

How the steps are held.—You may be able to examine an open staircase from below. If so, you can see how the steps are held in place. The boards at the sides are usually thick, and in these shallow slots are cut as shown in the drawing. Into these slots the boards forming the stairs are fitted. It will be seen that each step is firmly held at both ends. The horizontal boards, or "treads," are sometimes further strengthened by

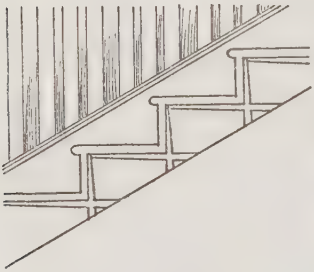

Fig. 36.

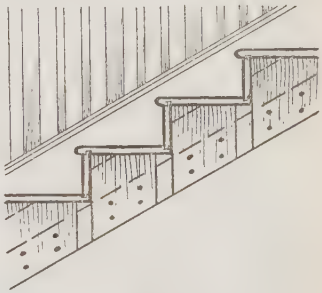

Fig. 37.

driving in glued wedges below the boards. Triangular wedges are also glued in the angles where the treads and the uprights meet. The only way in which stairs can collapse is by the sides opening out. This is prevented by binding the two sides together with cross bars.

In some stairs the boards at the sides are cut and the steps are nailed in place. Each step then helps to prevent any movement in the side boards.

Slope of stairs.—Measure the height and width of a step (omitting the projecting "nose"). You can then measure the angle at which the stairs slope by drawing these lengths at right angles to a scale of, say, a quarter.

Stairs are uncomfortably steep if the angle is more

than 40°, and uncomfortably shallow if the angle is less than 25°. In well proportioned stairs it has been found that :

Height in inches × tread in inches should equal about 63. If the tread, for example, is 12 inches, the height should be $5\frac{1}{4}$ inches. If the tread is 9 inches the height should be 7 inches.

When you come across uncomfortable staircases look for the reason. They may be too steep or too shallow, or they may be badly proportioned. In some cases the tread is so wide that it is impossible to mount the stairs at one pace to each step. The drawing shows a very uncomfortable kind of flight of steps sometimes found in front of public buildings. The discomfort arises in trying to mount these steps at the sides. They are only intended to be mounted from the front.

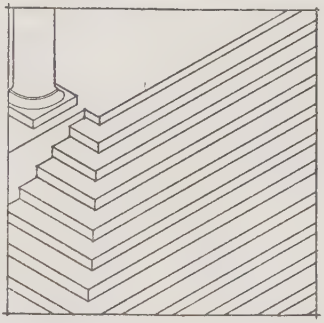

Fig. 38.

Turnings in staircases.—Examine a staircase where there is a turning. Sometimes the difficulty is got over by making two staircases with a square landing where they join. Where there is not room for this the stairs wind. In this case, each step is narrower at the inside than at the outside. The difference may be so great that the stairs are dangerously steep at the inside and uncomfortably wide at the outside. (Spiral staircases often have this fault.) You may find in some cases that the difference in width is lessened by beginning the winding before the turning point is actually reached.

Banisters.—Banisters are a protection at the sides of staircases. The distance between the rails should be so narrow that small children cannot get through. Examine the rails separately, especially at the base.

The rail should be thick and strong here to allow of firm attachment to the stairs. Any hard sudden pressure at the top is distributed by the handrail, but the attachment at the bottom resists the pressure.

The height of the hand-rail is usually about forty inches. (This is a convenient height for adults—who do not use the rail !)

XVIII.—FIREPLACES

FIREPLACES are intended to hold fires for heating rooms, without allowing smoke to enter the room. The chimney is, in addition, an important means of ventilation.

Where the heat goes.—Watch a fire burning, especially just after it has been lighted. Very soon smoke is carried up the chimney and flames are drawn in the same direction. Air may be felt moving toward the chimney, or this may be shown more clearly by holding smouldering paper near the opening. Smoke is carried up the chimney by currents of warm air. The heavier cold air in the room pushes up the lighter warm air in the chimney. You may have noticed that fires burn well in frosty weather. This is because there is a greater difference in weight between the cold air and the warm air in the chimney.

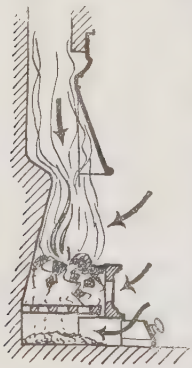

Fig. 39.

A great part of the heat of a fire goes up the chimney—this is the price we pay for keeping smoke out of the room. But there may be a considerable difference between one grate and another. Modern grates are made so that they stand well out into the room. A small fire in a grate of this kind may give out more heat than a large fire in a grate that is flat to the wall. (This is a matter that Scouts can easily put right in their own

homes. Grates can be bought quite cheaply that will fit into the flat grates often put in by builders.)

Making a fire.—You can experiment in making fires. The things required are—something to burn and a good supply of air to enable it to burn. Crumpled paper burns readily because it is thin and the crumpling surrounds it with air. Dry sticks built up crossways allow air to pass through.

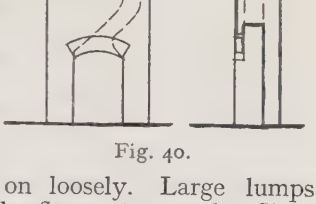

Fig. 40.

Coal should also be piled on loosely. Large lumps have only a small area for the flames to attack. Very small coal has no large air spaces. The best coal, therefore, for starting a fire is small knobs.

Make sure also that there is a clear airway under the fire as well as through it. A fire which is burning badly may be improved by clearing away ashes in the grate and below it. Sometimes there is a ventilator at the bottom of the grate which must be opened to admit air.

In case of fire.—Set fire to a sheet of paper. Try to put it out by waving it about. You will find that it burns better, because you are giving it a constant supply of fresh air. Now put it down on the hearth. It will burn quietly, or it may go out, because you have cut off part of the air supply.

In case of fire the dangerous thing is to give the burning thing fresh air, for example, by running about when clothing catches fire. To check the fire, smother it by rolling on the floor or by rolling yourself in a rug.

A fireplace as ventilator.—A room with a fire has an added means of ventilation. Even when there is no fire there is an outlet to the open air. Chimneys therefore should be kept open and free from soot.

XIX.—DRAINS

DRAINS are intended to carry away waste water, and to prevent obnoxious gases getting back into the house.

Traps.—The method of preventing gases returning along drain pipes is to insert a trap. Traps are made in different forms, but the bend shown in the diagram illustrates how they work. Any liquid matter flowing down the pipe passes along the bend, but there is always the water actually in the bend to prevent the return of gases.

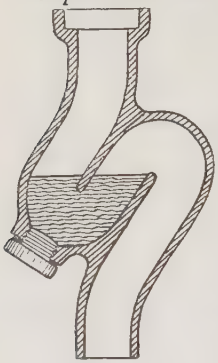

Fig. 41.

You will find a trap of this kind in the waste pipe from a wash basin. The screw at the lowest point allows the trap to be opened to clear out any solid matter which has gathered there.

A waste pipe may be cleared by opening the trap, or by using a rubber cup sold for this purpose. When the pipe is choked, fill it with water, place the cup flatly over the end, and press down the handle suddenly. The pressure on the water is usually sufficient to drive out the obstruction.

Fig. 42.

Gratings.—You will find gratings placed over waste pipes both in the house and outside. These are to prevent solid matter getting through and choking the pipes. These gratings should be kept clear.

The rush of waste water from baths is usually enough to flush the drains outside and keep them clear. It may however be necessary to raise the grating and clear out solid matter from the trap below. When this has been done the drain should be well flushed by allowing a bathful of water to run through it.

Ventilation.—In following the waste pipes from the house, you may note a pipe rising above the eaves and open at the top. This is to ventilate the drain by allowing gas to escape into the air above the house.

XX.—DOORS

EXAMINE a well-made door. It will be found that it turns easily on its hinges; it does not scrape on the floor; and it shuts with very little space to spare all round. A badly made door catches and leaves gaps.

The framework.—The problem in making a door is to prevent a heavy mass from warping. Examine the top of a door. You will find that the upright posts are let into the top bar so that they come right through. You will also find that the cross bars are similarly let into the upright posts. Further, there is a wedge at the top and bottom of each cross bar. When the door is being made the cross bars are put in their places; glued wedges are then hammered in above and below them. When the glue has hardened the cross bars are firmly held in place by a joint expanding outward. The framework of the door is thus firmly fixed so that it cannot warp.

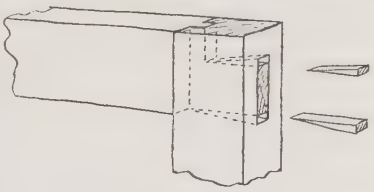

Fig. 43.

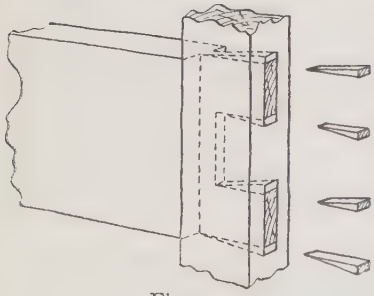

Fig. 44.

The panels are less important. They are simply glued to the rigid framework.

Hinges.—Examine the hinges of a door, and notice how they are let into the wood so that the door may close exactly.

Notice also the recesses in the posts, which prevent the door going back too far, and check draughts.

XXI.—LOCKS

INNER doors in houses often have cheap locks which go wrong. It is quite easy to detach one of these locks, examine it, and put it right. Take off the handle, and then take out the screws that hold the lock to the door. Turn the lock over, and take out the screw that holds the sides together.

Single-tumbler lock.—The drawing shows the simplest kind of lock—a single-tumbler. It consists of a bolt held in place by the opening at one end, and at the other end by a pin moving in a groove. The pin keeps the bolt from moving too far in either direction.

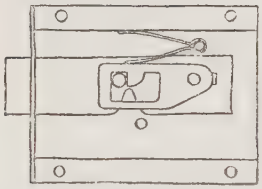

Fig. 45.

In the lower edge of the bolt is a space in which the end of the key moves to turn the bolt from side to side. Turn the key backwards and forwards and notice how it moves the bolt.

Lift out the bolt. Beneath is an iron plate pivoted at one end and held down by a spring. Turn the key and notice how it raises the plate.

Examine the back of the bolt. There is a projection here. When the plate is down, the bolt cannot move. You will see that the key does two things—it raises the plate and so clears the pin, and at the same time it moves the bolt.

Turn the key to and fro, and notice how the wards fit into the spaces in the key. If the holes were in different places the key would not pass the wards. It is always possible to open locks like this by using skeleton keys. These have narrow strips to lift the pin and turn the bolt, and no metal to be held by the wards.

Lever locks.—You may find a door fitted with a lever lock. Fig. 46 shows the appearance of the bolt. The key turns the bolt as in a single-tumbler lock.

Notice the pin sliding in a groove with several notches. You will see that the key raises the pin just the right height to pass along the groove. If the key were too long the pin would catch above; if it were too short the pin would catch below.

Remove the bolt and you will find that the pin projects from a lever. This lever is raised by the key as it turns.

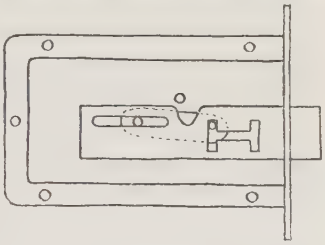

Fig. 46.

There may be several levers one behind the other. Each has a pin sliding in a groove in the bolt. The key is cut so that each part raises the lever it touches to the correct height to allow the pin to slide along its groove.

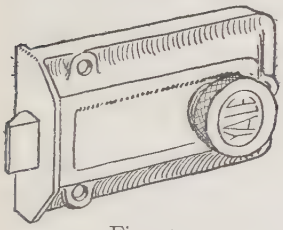

Fig. 47.

Cleaning a lock.—Locks often work badly because they are clogged with dirt. The dirt may be removed with an oily rag, which will also oil the lock.

Before closing the lock see that the spring is over the rod and that the bolt is on its pin (in a single-tumbler).

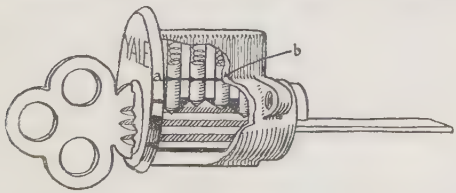

Fig. 48.

In a lever lock see that the pins are in their grooves. Test with the key before screwing the lock to the door.

Yale locks.—The most interesting part of a Yale

lock is the wards, which are difficult to see. When you turn the key in a Yale lock the whole barrel revolves, and so becomes a key turning a bolt behind.

The wards are metal rods held down by springs. When the key is inserted, the rods are pushed up. Each rod is in two parts, and when a suitable key is inserted the divisions are all along the line *a b*. A slight variation in the key would raise at least one rod to the wrong height, and this rod would prevent the barrel turning and so moving the bolt.

XXII.—WINDOWS

THE purpose of a window is to admit light. It should not admit draughts.

The window frame.—Examine the frame first. There are two grooves on each side for the window sashes to slide in. Outside the window at the top is a rod to keep out draughts when the window is closed. At the bottom the rod is inside. The rods forming the grooves serve the same purpose at the sides.

Fig. 49.

Near the top of the window at each side there are pulley wheels, over which slide window cords. Inside the frame the cords are attached to long weights; outside they are nailed to the window sashes. Two weights together—one on each side—are just enough to balance the weight of a sash. The result is that the heavy sash can be moved up or down with ease.

It is dangerous to leave windows with broken sash cords. The heavy window may come crashing down on the fingers if it is not balanced by the weights. To get at the weights and repair the cords it is necessary to prise off the rods which run down the window frame with a chisel.

The window sash.—Window sashes are made to overlap at the middle so as to exclude draughts.

Look carefully to see how the glass panes are fixed in place. On the inside each pane is held by a rim of the frame; outside, it is held by putty.

One or two points in the fixing of panes may be noted. The best method of investigation is to put in a small pane yourself.

In measuring the pane, see that you get the exact size of the space into which it is to fit. (Clear away the putty with knife or chisel before measuring.) See that your measurements are made exactly upright and exactly straight across the window (measure along the edges); otherwise you will find your measurements too great. You will need some small flat brads to hold the pane in position whilst the putty is being put in.

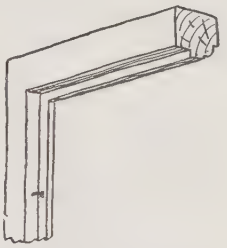

Fig. 50.

Begin by putting a thin layer of putty evenly all round the recess. Press it down with the knife. Now put the pane in its place, and press it well into the putty. Drive two flat brads into the wood at each side. Place them flat on the glass and let the hammer slide along the glass when hammering them in. Put putty all round. Take a small quantity at a time, press it well down with the knife, and smooth it off with the flat blade. Cut away any unnecessary putty, inside and out, with the knife. Leave the putty to harden before cleaning the window.

(Putty is whiting—finely powdered chalk—mixed with linseed oil.)

Window catches.—Window catches, intended to prevent windows being opened from outside, are sometimes not very efficient. It is possible to move the catch by inserting a knife between the sashes.

Windows may be more efficiently secured by means of

screws driven into the woodwork, so that the sashes together cannot be raised sufficiently to admit a man. This sort of protection is especially necessary where windows on the ground floor are left open for ventilation.

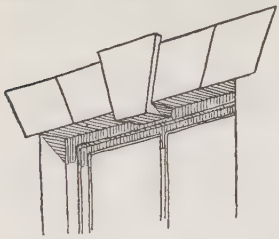

Fig. 51.

Arches over windows.—Small windows are built with a lintel or cross-bar of wood. This is sufficient to bear the pressure from above. You will find, however, that large windows are arched in some way. Dovetailed stones may serve the same purpose as arching, as for example, the stones shown in Fig. 51.

XXIII.—VENTILATION

WELL-MADE windows and doors keep out air—which is a pity. You may notice how stuffy a room becomes when doors and windows are closed. Climb to the top of a step-ladder in a closed room. You will find that the air near the ceiling is hot and very stuffy.

Clothes rails are sometimes fixed so that they can be drawn up near the ceiling. This is a good plan because clothes dry quickly in the warm upper air.

Fresh air is necessary to health, and the methods of admitting it should be carefully examined.

Air through cracks.—Hold your hand at the bottom of a door and at the place where window sashes meet. You will usually find a strong draught. This is not the best way of admitting air, but it is better than no way at all. People sometimes put mats down at doors and covers along the ledges of windows in order to keep out—fresh air and health!

Windows.—On a calm day, open a window both at top and bottom. Hold a piece of smouldering paper near each opening in turn. It will be found that there is an outward current at the top and an inward current

at the bottom. Thus stale air is continually being replaced by fresh air when windows are open like this. (Note the importance of leaving bedroom windows open top and bottom.)

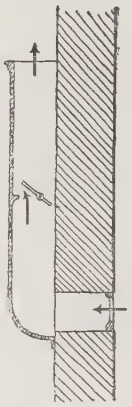

Fig. 52.

Chimneys.—When a fire is lit, smoke and flame are seen to be carried upward with the air which ascends the chimney.

Chimneys are thus seen to be valuable as ventilators, especially when a fire is burning.

Through draughts.—Well-made doors and windows check ventilation, unless they are left open. A stuffy house may be ventilated quickly by leaving doors and windows open so that there is a through draught. This effect may be tested at any time, especially on sultry summer days.

Other ventilating devices.—Examine the outside walls of the house for perforated bricks intended to admit fresh air. Other devices may be employed. Windows are sometimes arranged so that they direct draughts upward. Tobin tubes have the same effect.

XXIV.—LIGHT

Light is as important in rooms as fresh air. The methods of lighting rooms should therefore be carefully observed. The effect of pulling back curtains as far as possible should be noted in the evening when it is becoming too dark to read. Pulling back the curtains may give an extra half hour of daylight in a room.

Lighting a dark room.—Examine a dark room point by point. The ceiling may be "white." But put a sheet of white paper on it for comparison, and you may find that the ceiling is nearer black than white.

Examine the walls in the same way. You may find that the colour is very dark even when it pretends to be light. Skirting boards and doors may be painted dark brown.

In order to lighten a dark room it is necessary to make the dark parts really light. The ceiling should be quite white, the walls should be light coloured, doors and skirting boards should be white or cream.

As an experiment, on a dark evening, put a white tablecloth on a dark table. The lighting effect will be seen at once.

Light from outside.—Now look outside the window. The light which enters the room comes from the sky. Anything between the sky and the window is shutting out light. It may be possible to remove creepers or trees.

In the last resort, a high fence outside the window may be whitewashed, and a reflector may be placed outside the window. Reflectors are fixed at an angle of 45° with the level, so that they reflect into the room light from the bright sky overhead.

XXV.—SHELVES

The difficulty in fixing up a shelf is to make it rigid, or nearly so.

Fixing shelves.—Shelves are sometimes fixed across recesses. This is a convenient method, because both ends can be firmly held. All that is needed is to fix two rests for the shelf (Fig. 53).

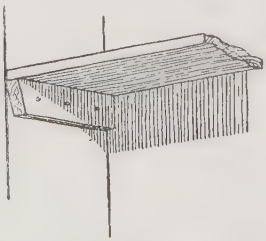

Fig. 53.

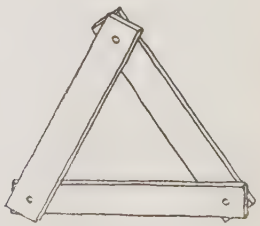

Fig. 54.

Where the shelf is very long, or where the ends cannot be fixed, triangular brackets may be used.

The effect of a triangular bracket may be shown by

experiment. Pin three strips of wood together to form a triangle (Fig. 54). You will find that you cannot change the shape of the triangle without breaking the joints. With four rods the shape may be changed easily.

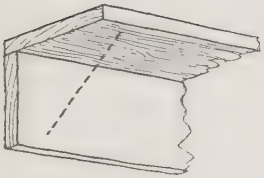

Fig. 55.

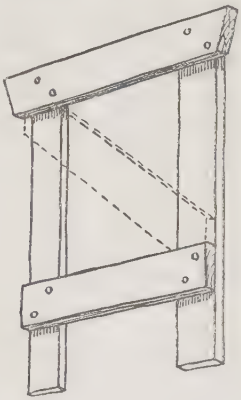

Fig. 56.

Shelves may often be strengthened by introducing a triangle. For example, the shelf shown in Fig. 55 may be strengthened by nailing a wooden rod across where the dotted line is. The same method may be used to make the legs of benches rigid (Fig. 56).

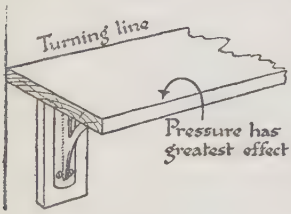

Fig. 57.

Loading a shelf.—Even the most strongly fixed shelf will not bear a very great load. If heavy things are to be placed on a shelf it would be well to consider which are the most suitable places.

Think of the shelf as a lever. Where it is bracketed to a wall, the turning line is along the wall, and pressure on the outside edge will have most effect.

In a shelf fixed at the ends (in a recess or in a bookcase) the turning lines are at the ends, and pressure at the middle has the greatest effect. This may be tested by pressing at different parts with the fingers.

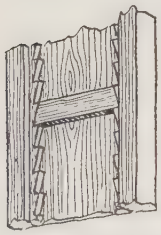

Fig. 58.

Heavy weights should therefore be placed near the ends of shelves fixed at the ends, and near the back of shelves fixed with brackets.

Movable shelves.—Bookcases are often made with shelves that can be raised or lowered. Various methods are used for fixing them. One of the commonest is the series of steps shown in Fig. 58. The shelf rests on the crosspiece between the steps.

XXVI.—WATER-TAPS

WATER-TAPS are intended to allow a flow of water from the water main when it is required, and to check the flow when it is not required.

How water is admitted.—There are several types of tap in use. The pipe from the main passes to the outflow pipe, and between them is the tap. In most taps there is a screw, which moves down so as to cover the opening. By turning the handle the screw is raised, the pipe is opened, and water flows through.

In another type of tap there is a hole through the plug. When the handle is turned the hole is brought in line with the pipe so that water can flow through. In another type a ball closes the pipe. The ball is pushed out of the way by pressing down the top of the tap.

Two supplies of water.—There are usually two supplies of water. Cold water for drinking may be traced from the main pipe outside the house directly to the taps. Follow also the direction of the pipe that leads to the cistern at the top of the house. From this, pipes may be traced down to the boiler, and then to the hot-water pipes.

Turn on two taps belonging to the same system (*e. g.* the cold taps at the bath and in the kitchen). It will be found that the upper tap almost ceases to run. Test other taps in the same way until you have found which taps belong to each system.

Leaking taps.—If there is a leaking tap it would be interesting to find the waste of water caused in this way. Hold a half-pint tumbler under the tap and find the time taken to fill it. Then calculate the waste of water in 24 hours and in a year. In addition, you might calculate the waste if all the taps in the house, and all the taps in the town, were leaking.

Washers.—Where a tap leaks it is usually because the washer is worn, and it is necessary to put on a new one. The first thing is to buy a washer, the next to reduce the water pressure by turning on all the taps belonging to the system to which the leaking tap belongs. When this has been done, unscrew the tap by turning it in the reverse direction to that for turning it on. A spanner or a pair of pincers must be used for this purpose.

When the tap has been unscrewed, take off the old washer, put the new one in its place, and screw up the tap again.

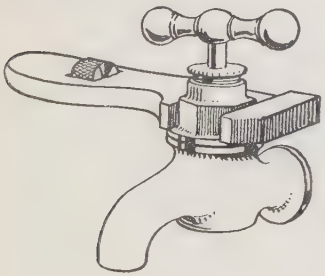

Fig. 59.

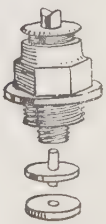

Fig. 60.

Frozen pipes.—During a hard frost the water in pipes may freeze. When this happens there is danger of the pipe bursting. (Water expands when it freezes. This is

shown by the fact that ice floats on water—because it is lighter than water. The amount of expansion is one-tenth. One pint of water—weighing 20 ounces—becomes $1\frac{1}{10}$ pints of ice—weighing 20 ounces.)

There are two ways of preventing the bursting of pipes. One is to allow taps to drip slightly during frosts. The other method is to hammer the lead pipes slightly flat. If the pipe is not circular (as at A) it can be increased in size by being made round. When it is circular (as at B) no further increase is possible without bursting outward. Dents and flat parts of lead pipes, therefore, act as safety valves.

Fig. 61.

When denting lead pipes, turn on the taps, and only strike the pipes gently.

The water main.—Find out where water is admitted to the house from the main pipe, so that if anything goes wrong the supply may be cut off at once.

XXVII.—CISTERNS

THE purpose of cisterns in houses is to provide a good pressure of water by slowly accumulating a supply near the top of the house.

How water is admitted.—Look for the open pipe near

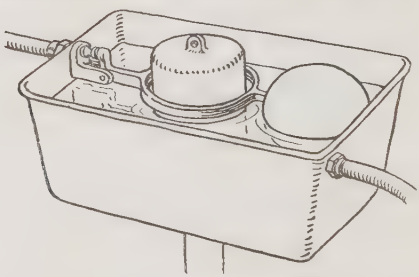
Fig. 62.

the top of the cistern where water runs in, also for the outlet pipe near the bottom.

The most interesting point is the method by which the inflow of water is stopped when the cistern is full. You will see the ball that floats up with the water. The end of the rod attached to the ball is hinged, so that the rod gradually closes the inlet pipe as the ball rises.

Flushing cisterns.—Flushing cisterns are intended to give a sudden rush of water. In many of them the water is made to siphon over. You can show the working of a siphon with a tumbler of water and a piece of tubing—either bent glass or rubber. Fill the tubing with water by putting it in a basin of water, cover the ends with the fingers, put one end under water in the tumbler, and open the other end. The whole of the water may be taken out of the tumbler in this way.

Fig. 63.

Look into the cistern, and you will see that the lever across the top is attached to a heavy iron cylinder. This is closed at the top, and round the base there is a wide flange, which just fits into an open cylinder. The

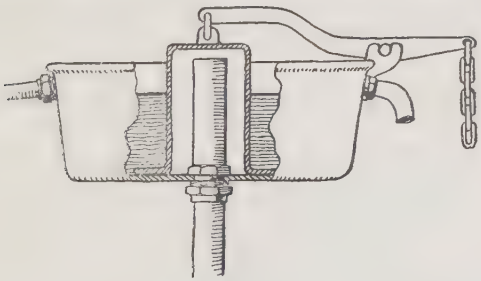

Fig. 64.

closed cylinder may be lifted out. Beneath it you will find a wide pipe reaching nearly to the top of the cylinder. The siphon is formed by the closed cylinder and the open pipe under it.

The cistern fills up with water and the flow is stopped by the valve. The siphon is then nearly full. (If it were quite full the water would be siphoned down the pipe.)

When the plug is pulled the closed cylinder is raised. When you let go, it falls, and the flange presses the water below it into the closed cylinder and the pipe under it. The siphon is thus filled, and water runs down the pipe until the cistern is empty.

Safety valves.—Near the top of a cistern you will find an open pipe leading from it and out of the house.

This pipe acts as a safety valve. It carries off (or should carry off) the inflowing water if the valve checking the flow should cease to act. Overflow pipes should be examined occasionally to see that they do not become blocked up.

Similar safety valves may be noted on wash basins and baths.

XXVIII.—HOT WATER SUPPLY

It may be possible to trace hot water pipes, especially when the water is hot, from the tap toward the boiler.

The boiler.—The boiler is usually placed behind a fireplace so that flames and hot air pass round it and under it.

Near the bottom of the boiler is an inlet pipe from the cistern. At the top is an outlet pipe for the heated water.

Hot water is lighter than cold, so that as the water in the boiler is heated it is pushed up to the top of the boiler. The hottest water is thus drawn off from the top.

Storage cylinder.—There is often a storage cylinder for hot water. This acts in the same way as the boiler. Hot water from the latter enters the cylinder and is pushed up to the top. The hottest water is drawn off from the top of the cylinder. (Hot water pipes pass from the top of the cylinder to the taps.)

XXIX.—GAS FIRES

Gas fires are intended to supply heat without soot.

Parts of a gas ring.—Examine a gas ring. There is the ring of holes with gas jets, and the gas pipe leading to the ring. In this pipe there is a hole to admit air.

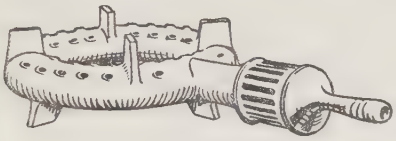

Fig. 65.

Light the gas and cover the air hole with a piece of paper. The blue flame at once becomes yellow. Open the hole to admit air, and the flame becomes blue again.

Put a tin lid over the flame and cover the air hole. Examine the lid after a time and you will find it covered with soot. This soot is unburnt carbon from the gas. When air is admitted the gas is more completely burnt and no unburnt soot is left.

You can show that the completely burnt gas gives a hotter flame than the partly burnt gas (the yellow flame) by timing a tin of water over each, noting the time each takes to boil.

If the flame is at all yellow, examine the air hole and clear it if necessary. Sometimes too much air is admitted and the flame roars. If this happens, the air hole may be partly covered with a strip of tin cut from a tin can. Move the tin till the flame burns quietly without a trace of yellow.

Gas ovens.—You will find similar parts in a gas oven. It is even more important in this case to keep the burners free from soot and dirt. Near the top of the oven you will find a ventilator. This is to allow the burnt gases to escape, whilst fresh air enters from below. If there is not enough ventilation the gas flame goes out.

Examine the sides and door of a gas oven. You will find that they are very thick. They are packed with asbestos, a substance which is a bad conductor of heat. The effect is to check the escape of heat from the oven.

A large gas oven into which gas has been admitted may cause a dangerous explosion. There is no possibility of this if the gas is lighted in the correct way. Open the door wide; strike a match and hold it near the burners; turn on the tap.

Gas fires.—Gas fires also have burners and an air hole. In addition, there are lumps of fireclay. These are

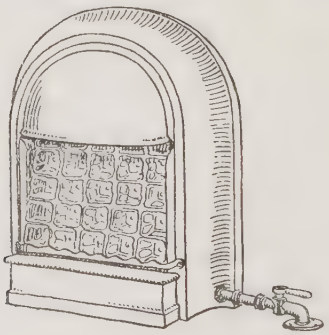

Fig. 66.

heated by the gas, and they give a large surface for radiating heat into the room. You may note how the fireclay is formed to give a large radiating surface. The greater the surface, the more efficient is the fire.

The outside of a gas fire is metal, which carries heat away quickly. The parts near the flame should not, therefore, be metal, but fireclay. Examine the gas fire and see whether there is any metal by which heat can escape from the room.

Look also to see what becomes of the burnt gases. Do they escape into the room, or is there a flue along which they reach the chimney?

A gas fire may dry the air too much. This difficulty is easily overcome by leaving a flat basin of water near the fire to evaporate.

Gas lighting.—The old method of using the yellow flame was dirty and inefficient. If you see a yellow gas flame, look for a dark patch of soot above it.

The incandescent gas burner uses the blue flame. The air holes should be regulated so that the flame

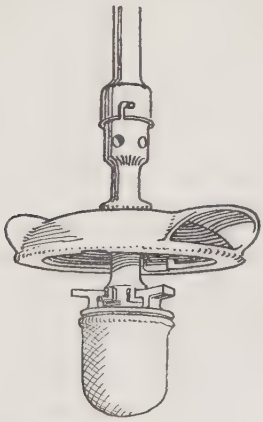

Fig. 67.

is quiet and without any trace of yellow. Light is obtained from the heating of the mantle white hot.

XXX.—A GAS METER

A GAS meter measures the quantity of gas which passes through it. Unfortunately the most interesting parts of a meter are hidden. The parts that can be seen are the outer case, a pipe leading into it below, another pipe leading out above, and the dials which register the quantity of gas used.

Look for the tap which can be used to cut off the supply of gas before it enters the meter. If there should

be a leakage of gas, cut off the supply at the meter, open doors and windows, and see that there are no naked lights.

Coal gas is made with an unpleasant smell in order that a leakage may be detected at once.

Reading the gas meter.—The dials show the number of cubic feet, and the quantity may be read off at any time. Begin with the dial which shows the largest quantities (in this case 100,000's). The reading is 7 + (or 7 and a bit—the other dials show the size of the bit). The second dial reads 5+, the third 1+, and the fourth 1; so that the reading is 700,000 + 50,000 + 1,000 + 100. The total is therefore 751,100.

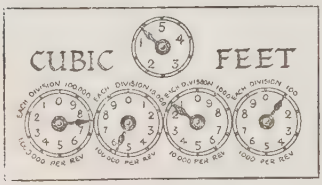

Fig. 68.

You may be able to see that it is only necessary to write down in order the smaller of the two numbers between which the pointer stands (in the case of 9 and 0 write 9). Then add two 0's.

The quantity of gas used.—To find the quantity of gas used since the last examination, look at the card filled in by the meter inspector.

Date.	Reading.	Cubic feet used.
Jan. 3 . .	43,600	——
Mar. 31 .	54,500	10,900
Jy. 1 . .	60,900	6,400
Sept. 29 .	65,100	4,200
Jan. 2 . .	79,300	14,200
Apl. 3 . .	93,800	14,500

Since April 3 the amount used has been :

97,000 (shown by the meter)
less 93,800 (the last reading)

3,200 cu. ft.

An electric meter may be read in the same way as a gas meter.

How the wheels go round.—Behind the dials are cogged wheels. A rotates in the direction shown. The smaller cog wheel behind A turns B, so that B turns in the reverse direction. The larger wheel is ten times the size of the smaller, so that B turns only once for ten turns of A. Similarly C turns once for ten turns of B, and so on.

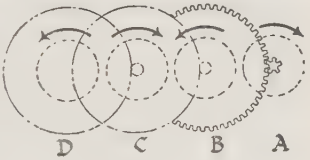

Fig. 69.

How the meter measures the quantity of gas.—The lower part of a meter contains a double concertina arrangement. Gas enters at one side and opens out the concertina. When it is full, the outlet pipe is opened, and this quantity of gas may pass into the pipes. Gas meanwhile begins to fill out the concertina on the other side. Inlet and outlet pipes are opened and closed by sliding valves as the concertinas open and close.

Each time a concertina opens it turns a lever, so that each turn of the lever registers one concertina full of gas. The movements of the lever are carried by levers and cogwheels to the dials.

Penny-in-the-slot meters.—One form of penny-in-the-slot meter is shown in Fig. 70. When a penny is put in it joins the wheels A and B, so that the inner wheel may be turned by the outside knob. After a certain distance the penny meets a slot, into which it falls, and the inner wheel can no longer be turned.

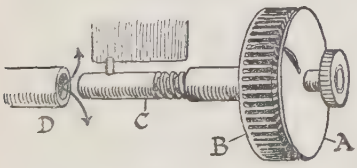

Fig. 70.

The inner wheel is attached to a screw. The turn of the wheel withdraws the screw and so opens the gas-pipe D. The screw C may be withdrawn still further by using pennies to turn the wheel B.

As the gas escapes through the pipe it turns a wheel, which causes the screw C to move back until it closes the pipe again.

Therms.—Gas meters register the quantity of gas used in cubic feet. Gas is now, however, charged at so much per therm.

The quality of gas varies very much—one supply gives more heat than another. The therm charge is based on the quantity of heat obtained from the gas supplied. The unit of heat is the quantity required to raise a pound of water one degree (Fahrenheit) in temperature. (1000 units of heat, for example, would raise 10 pounds or one gallon of water from 50° F. to 150° F., or 100 pounds of water from 50° F. to 60° F.)

The heating power of gas is tested by means of an elaborate " calorimeter," or heat measurer. One cubic foot of gas supplies so many units of heat. The actual number in each case must be stated by the gas company. To find the number of units of heat used, multiply the number of cubic feet by the heat value of the gas.

A therm is 100,000 of these units of heat, so that :

$$\text{Number of therms} = \frac{\text{cubic feet of gas} \times \text{heat value}}{100{,}000}$$

XXXI.—ELECTRIC LIGHT

An electric bulb.—Examine an electric bulb. You will see in it a thin wire twisted in coils. The ends of the wire pass up into the neck of the bulb to the two broad terminals at the top. The wire is continuous. The passage of an electric current through this wire makes it white hot, so that it gives a bright light. If the wire breaks, the current and the light stop at once. The only way of restoring the current is to bring the broken ends together. To do this, switch on the current and wave the bulb about gently. The broken ends will probably vibrate and so come together. When this happens they at once fuse and the light is restored.

Take an old bulb (which no shaking will cause to give

a light). Hold it under water and very carefully pinch off the tip with a pair of pincers. Water will rush in until only a small bubble of gas remains. This shows how the bulb was exhausted. The gas is one of the inert gases (often helium). If air were used the oxygen would unite with the heated filament and so cause it to break much sooner.

Somewhere on the bulb, either on the glass or on the brass neck, you will find two marks :

110 VOLTS
50 C.P.

Fig. 71.

The upper mark gives the electric pressure which is suited to the lamp. Before buying a new lamp you should find out the voltage of the current supplied (from the meter or the card on which the units used are recorded). If the voltage of your lamp is too low it will not stand the current and the filament may *fuse*. If the voltage is too high the current will not be powerful enough to heat the wires sufficiently.

The lower mark gives the amount of light (the candle power) to be expected when the lamp is used with the proper current. The higher the candlepower, the greater is the amount of current used. For small rooms 30 candlepower would give a good light. For larger rooms 40, 50, or more, would be needed.

Fig. 72.

The lower mark may be given as watts. In the usual type of lamp a watt may be taken as equivalent to one candlepower. In the "half-watt" type, one half watt is equivalent to one candlepower.

Fixing an electric lamp.—To put an electric bulb in place it is only necessary to push it into the fitting made for it, and turn it so that the spikes engage with the slots. The terminals on the bulb are then tightly pressed against the terminals of the wires in the fitting.

Shades.—Frosted glass shades are useful in spreading the light from electric lamps. If they are at all dark, however, or if they are allowed to become dusty, much of the light is wasted. Thin white paper makes a good shade.

XXXII.—AN ELECTRIC SWITCH

An electric switch is placed at a break in the wires so that the current may be allowed to flow or may be broken at will.

Examining a switch.—Before examining a switch, cut off the current at the main switch, and make sure that it *is* cut off by putting down the knob of the switch you are examining.

Unscrew the brass top of a switch. The part below is made of porcelain, which does not carry electricity. You will see how it is screwed to the wall.

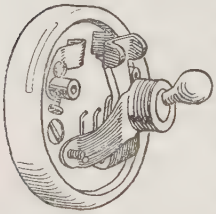

Fig. 73.

The ends of two wires will be seen held in set screws. These are the wires which carry the current, and the break is between them.

The knob raises or lowers two copper strips. You will see that when the knob is down, the copper strips press against the set screws and so complete the metal connection between the wires. When the knob is raised the connection is broken.

Putting a switch right.—If there is no current in one room whilst there is in others, very probably the switch is wrong.

Before attempting to put it right, cut off the current at the main switch.

Tighten the screws with a small screwdriver. Press the copper strips out a little so that they may press tightly against the set-screws. (They should be a tight fit into the spaces made for them.)

If there is still no current, unscrew the switch and look for a break in the wires.

XXXIII.—AN ELECTRIC FUSE

NEAR the electric meter you will see small oblong porcelain boxes. These contain the safety fuses. Switch off the current at the meter and you can examine these.

The fuse box.—Unscrew the top of the fuse box and take it off. Below you will find the ends of two wires fixed in binding screws. There is a strip of whitish wire connecting the two wires. This is the fuse wire.

Fuse wire easily melts. So long as there is a safe electric pressure the current flows through the fuse wires without damaging them. A sudden increase in the pressure would heat the fuse wires and melt them.

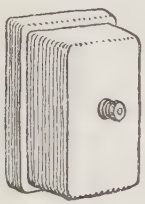

Fig. 74.

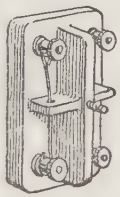

Fig. 75.

The circuit would thus be broken, and the current would stop.

It will be seen that fuse wires only allow currents at a safe pressure to enter the house, and thus they protect the electric lamps.

Replacing a fuse.—It is an easy matter to replace a fuse wire that has burnt out :—

1. *Switch off the current.*
2. Remove the fragments of the burnt wire.
3. Cut off a suitable length of fuse wire with the pliers.
4. Fix this across the screws and screw up tightly.
5. Replace the lid of the box before switching on the current again.

XXXIV.—AN ELECTRIC BELL

You may find four parts to an electric bell—the bell itself, a battery of two or three electric cells, the bell push, and covered wires connecting them. Where electricity is used for lighting there may be no electric cells.

The bell.—It is usually easy to examine an electric bell. You will find that it consists of an electromagnet

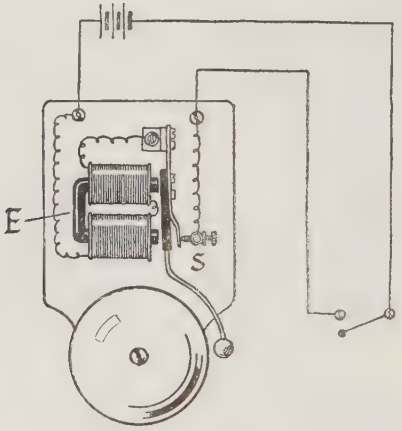

Fig. 76.

(marked E), wound with covered wire. Below is the gong. On the side of the magnet where the poles project is a rod ending in the hammer. Part of this rod is a piece of soft iron—an "armature." Behind the armature is a spring which presses against a screw (marked S).

The wiring.—Start at the battery and follow the wire. One wire is attached to the carbon of a cell. This wire may be traced to a binding screw above the bell. It is then wound round one pole of the electro-magnet, and without a break round the second pole.

It is then connected to the hammer rod. The second wire passes from the screw S back to the zinc of the second or third cell.

The bell push.—Somewhere on the wire is a break. The bell push is a means of closing this break at will. When the push is pressed, the break is closed by a strip of metal.

How the bell works.—Follow the direction of a current (when the break is closed by pressing the bell push) from the carbon to the bell, through the electromagnet, along the spring, through the screw S, and so back to the battery.

As soon as the current flows, the electromagnet becomes a magnet. It attracts the armature and so causes the hammer to strike the gong. But you will see that this causes a break between the spring and the screw S. This stops the current; the magnet ceases to attract the armature, the armature springs back, and the current begins to flow again. Every ping of the bell means a separate make and break of the current.

Repairing an electric bell.—Examine each part in turn, testing the bell each time.

1. The bell: Examine the wires and tighten the screws. Press the armature against the magnet and see that the spring is clear of the screw S. See also that the spring presses on the screw when the armature is released. See that the hammer touches the gong when the armature is pressed up.

2. The bell push: Unscrew the top. See that the ends of the wires project, and that the metal strip joins them when the push is pressed down.

3. The wires: Follow the wires and see that there are no breaks or places where the wire is uncovered.

The electric cells.—The cells are Leclanché cells. Each consists of a large glass jar nearly full of liquid, in which stand a zinc rod and a porous pot. The porous pot contains a carbon rod packed round with manganese dioxide.

The liquid is water containing sal ammoniac. The jars should be kept three-quarters full of water, and there should be some undissolved sal ammoniac at the bottom.

See that the wires are tightly connected to the zinc

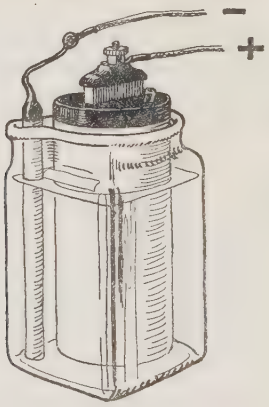

Fig. 77.

and the carbon. The carbon wire (+) of one cell is joined to the zinc (—) of the next. The wires from the free poles pass to the bell.

XXXV.—CONDUCTORS OF HEAT

Good conductors allow heat to pass through them readily. Bad conductors check the flow of heat.

Bad conductors.—You can usually decide between good and bad conductors of heat by touching them. A good conductor (a metal, for example) carries away heat from the hand so that the hand feels cold. A bad conductor, on the other hand, checks the flow of heat, so that the hand does not feel cold.

Many bad conductors are used in the home to check the flow of heat from hot things to the hand. A flat iron is made very hot so that it would scorch the bare

hand. To prevent this, a bad conductor is used in lifting it. This may be a holder made of flannel, though several thicknesses of paper will do quite well.

Metals are good conductors of heat, so that hot things made of metal require the use of bad conductors. Silver teapots often have ebonite handles, and wooden handles are often found on tools meant to raise hot objects.

Examine gas fires and ovens. A gas fire should be surrounded with bad conductors (fireclay), and the walls of a gas oven are usually packed with a bad conductor (asbestos).

Cork is a bad conductor, so that cork mats are used to prevent the escape of heat from the body.

Fluffy things.—Air is a bad conductor of heat, so that fluffy things are often used to check the flow of heat. This may be shown by experiment. Get two similar tins. Leave one as it is, and wrap the other lightly with wool. Fill both tins with hot water. After about a quarter of an hour, test the heat of the tins by dipping a finger in each. It will be found that the water is cooler in the unwrapped tin.

Fluffy material is used for clothing, for bed coverings and for floors. It may also be used for covering ice to prevent it melting.

Good conductors.—Occasionally good conductors are used in the home. To cool a hot liquid quickly, put it in a metal vessel and place it on a metal surface. Kettles are made of metal so that heat may pass through quickly to the water.

Look out for other cases in the home where good and bad conductors are used.

XXXVI.—GOOD AND BAD RADIATORS

As well as flowing along the material of substances, heat is radiated from them. It will be found that dull surfaces are good radiators, whereas polished surfaces are bad radiators.

Good radiators.—Some houses are heated by hot water radiators. Where these are used, two things may be

noticed. In the first place, the surface of the radiator is dull—it should not be polished. In addition, the radiator is not made in one solid whole, but is divided up so as to present a great radiating surface. By this means a large amount of heat is radiated into the room.

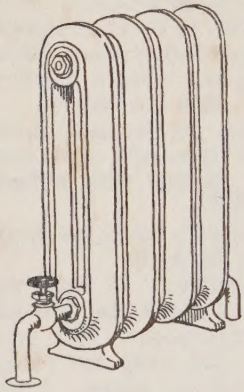

Fig. 78.

Examine the fireclay bricks in a gas fire. These also are made so that they have a large surface to radiate heat into the room.

Bad radiators.—Where it is desirable to keep in as much heat as possible bad radiators are used. These have polished surfaces, and they are as nearly globular as possible.

Teapots are intended to keep the tea hot. They should therefore be kept polished. The tea cosy is an additional protection against loss of heat.

The upper part of a kettle should be kept polished to check radiation of heat. The bottom should be dull to allow heat to pass through easily; but there should be no coating of soot, which is a bad conductor.

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